7.—New information about the Quaternary distribution of the thylacine (Marsupialia, Thylacinidae) in Australia

by M. Archer[1]

Manuscript received 22 May 1973; accepted 18 September 1973

Abstract

Thylacine remains and associated faunas are reported from cave deposits in the Kimberley Division, the South West Division and the Hampton Tableland of the Eucla Division of Western Australia. The thylacine remains from the Kimberly Region are the first reported from northern Australia. Bone from the same deposit in the Kimberley Region is radiocarbon dated at O ± 80 years B.P. (GaK-3890). This date may not apply to the thylacine remains in the deposit. The deposit from the South West Division contains thylacine remains which have been radiocarbon dated at 3090 ± 90 years B.P. (ANU-716). These are the youngest reported from the South West Division. The deposit from the Hampton Tableland and other published faunas (e.g., Wakefield 1964) provide evidence for considering that of several possible causes for the thylacine's decline, the most likely is competition with the introduced eutherian dog.

Introduction

Thylacinus cynocephalus has been reported from Quaternary deposits in New Guinea and all states of Australia except the Northern Territory (e.g. Van Deusen 1963, Partridge 1967, De Vis 1894, MacIntosh and Mahoney 1964, Gill 1953). It has never been postively recorded living within historic time from any area except Tasmania, although there are many records of sightings of thylacine—like animals unsupported by material evidence. Thylacines may still be living in certain remote areas of Tasmania but the last living individual captured in the wild was at Mawbanna in 1930 (Marlow 1968).

The most recent published dates for Australian mainland occurrences of thylacines are those recorded by Lawton and Twidale (1964) as between 3 240 ± 80 and 3 881 ± 85 radiocarbon years B.P. and by Partridge (1967) as 3280 ± 90 radiocarbon years B.P.

The taxonomy used in this paper is that adopted by Ride (1970). Catalogue numbers refer to specimens in the collections of the Western Australian Museum. Certain caves are listed with registration numbers given by the Western Australian Speleological Group (pers. com. Mr. P. J. Bridge). Western Australian cave names are given without the possessive " 's " in accord with the policy of the Lands and Surveys Department of Western Australia (e.g. Murray's Cave becomes Murray Cave).

[1] Western Australian Museum, Francis Street, Perth, Western Australia 6000.

Present address, Queensland Museum, Fortitude Valley, Queensland 4006.

The Kimberley Division

In 1970, Dr. R. E. Lemely, Mr. A. M. Douglas and the author collected bones and other remains within 11 cm of the surface of a small limestone pocket referred to by us as the "Tunnel Creek Carnivore Lair" in the wall of a collapsed doline, above Tunnel Creek in the Napier Range, of the southwestern Kimberley Division. The remains have been registered in the collections of the Western Australian Museum as 71.12.60 - 71.12.119.

The fauna includes the following taxa:

	Metatheria
Dasyuridae	*Phascogale* cf. *P. tapoatafa* *Antechinus* cf. *A. macdonnellensis* *Dasyurus hallucatus*
Thylacinidae	*Thylacinus* sp. (see Ride 1964 and Archer 1972 for comments about species)*
Peramelidae	*Isoodon* sp.* *Macrotis lagotis*
Phalangeridae	*Trichosurus* sp. or *Wyulda* sp.*
Petauridae	*Petropseudes dahli*
Macropodidae	*Peradorcas concinna* *Petrogale* cf. *P brachyotis* *Megaleia rufa**
	Eutheria
Muridae	*Pseudomys nanus* *P. forresti* *Zyzomys argurus* *Conilurus* cf. *C. penicillatus** *Mesembryomys* cf. *M. macrurus* *Rattus tunneyi*
Pteropodidae	*Pteropus* sp.*
Vespertilionidae	small bat (indet)
Megadermatidae	*Macroderma gigas*

* The specimens representing these taxa probably do not represent undescribed species. They were not specifically identified either because the material is post-cranial in nature (e.g., the thylacine specimen is a humerus, Fig. 1) or the described species of the taxa could not be adequately differentiated using only the characters present in the fossil specimens.

Non-mammal remains include two species of lizards, at least one species of snake, a catfish spine and fish vertebrate, fresh-water crabs, mussels, terrestrial snails, insects and spiders.

The specimens from this deposit representing *Macrotis lagotis, Petropseudes dahli, Peradorcas concinna* and *Conilurus penicillatus* represent range extensions for these species within the Kimberley region of Western Australia (Ride 1970). *Pseudomys forresti* has not previously been recorded from the Kimberley region.

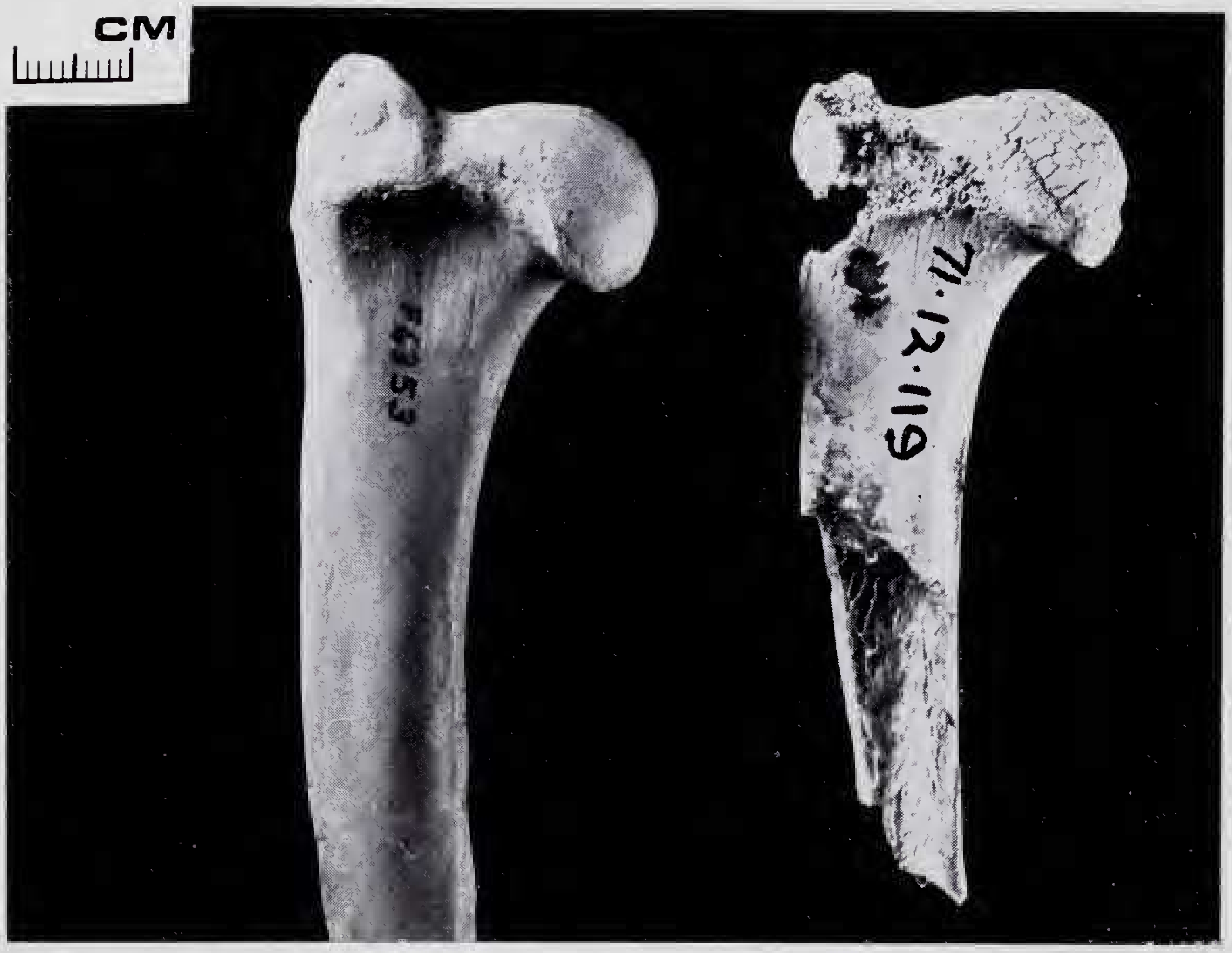

Figure 1.—The proximal portion of a thylacine humerus (71.12.119) from the Kimberley deposit. It is compared with the proximal end of a thylacine humerus (Geological Survey of Western Australia Number F6353) from a cave on the Hampton Tableland of the Eucla Basin of Western Australia. There is also a distal portion of a thylacine humerus (perhaps the same humerus) from the Kimberley deposit.

The vertebrate remains in the deposit probably represent a carnivore's accumulation. The larger species of marsupials are represented mainly by juvenile specimens. It is not uncommon behaviour for some "scavenger-predators" to specialize on juvenile as well as senile and sick individuals of larger prey species (Estes 1967). In addition the animals present in the deposit, such as the crabs, fresh-water mussels, arboreal *Phascogale* sp., and plains-dwelling *Megalia rufa* represent such diverse habitats that it is highly unlikely that their remains could have accumulated in one place without the assistance of some transporting agent. Because the limestone pocket is horizontal, shows no evidence of flooding, and has no entrances from above, contribution to the deposit by means of floods or animals dropping in from above seems improbable. It is most likely that some animal with catholic food habits accumulated the remains in one place.

The presence of the mussel shells and perhaps also the crab and fish remains suggest Aboriginal man may have been involved. He would certainly be able to procure mussels and crabs from the wet sand of Tunnel Creek. However, it is also possible that dogs or thylacines might be able to do the same thing. It may be significant that no burned bones or stone artifacts were recovered from the deposit. The "Tunnel Creek Carnivore Lair" limestone pocket is floored with irregular stones which made it very uncomfortable to sit or recline while trying to reach bone material on the surface which lay under low ledges at the margins as well as in the centre of the pocket. This suggests that Aborigines might not use the small pocket as a shelter.

Although Aborigines might have tossed things into this pocket, the absence of burned bones and artifacts suggests that the animal material was gathered by a non-human carnivore.

Much of the bone from this deposit is broken. The manner in which bone is broken often suggests which carnivore or other agency is responsible (e.g. Brain 1967, Douglas, Kendrick and Merrilees 1966, Lundelius 1966). The bone from the "Tunnell Creek Carnivore Lair" is not as thoroughly smashed as bone from certain undoubted archaeological deposits (e.g. Puntatjarpa, in the Warburton Range of Western Australia, report in press). On the other hand, Douglas, Kendrick and Merrilees (1966) have demonstrated the type of bone-breakage caused by *Sarcophilus harrisii* in which Bettong-sized and smaller animals are broken up into small pieces in a manner similar to bone broken by humans. The bones from the "Tunnel Creek Carnivore Lair" are not as thoroughly broken as this and may represent the activities of dogs or thylacines.

Bone fragments from the sample collected were submitted for radiocarbon dating. The result (Gak-3890) was 0 ± 80 radiocarbon years. It should be pointed out that because of variations in atmospheric C^{14} concentrations, this date might represent about 200 calendar years (Radiocarbon 1966). Other uncertainties and variables affecting the relialibility of such young dates are given in Polach and Golson (1966). Because the thylacine remains consist of only a broken humerus, the thylacine bone itself was not submitted as part of the radiocarbon sample. It is possible that the age of the thylacine bone differs from the age of the bone in the sample submitted for dating. The thylacine humerus is not as fresh-looking as some of the other bone in the sample. The possible difference in age of the various bones in the deposit cannot be determined.

Brandl (1972) reports Aboriginal rock-paintings in Arnhem Land of a striped animal which he interprets as possibly representing *Thylacinus*. This interpretation is convincing. Although the thylacine bone from the "Tunnel Creek Carnivore Lair" deposit reported here may not be the same age as the other bone in the deposit, these Arnhem Land rock-paintings reported by Brandl (1972) would seem to add support to the idea that thylacines may have survived in northern Australia until late recent time.

Wright (1968) reports rock art from the Pilbara Region of northwest Australia which he considers represents a dog-like mammal with vertical stripes and other features suggesting a thylacine.

The Pilbara Region is intermediate between the Kimberley area and the South West Division in Western Australia.

The South West Division

Excavation by Mr. I. Murray, Miss E. A. Jefferys and the author in a stratified deposit in Murray Cave (Yn52), formed in what is commonly referred to as "Coastal Limestone" (Smith 1963) about 40 km north of Perth recovered a fauna that included *Thylacinus cynocephalus* (to be reported fully elsewhere). Remains of thylacines (e.g. 72.1.1148) were collected from the surface of the cave floor and between the surface and 7 cm in the excavated deposit. A radiocarbon date (ANU-716) on charcoal from 1-7 cm is $3\,090 \pm 90$ radiocarbon years B.P. This is the youngest dated occurrence of thylacines from the South West Division of Western Australia. *Thylacinus cynocephalus* is recorded from the Mammoth Cave fauna which may be older than 31 500 years B.P. (Merrilees 1968). This is the only other dated occurrence of thylacines from the South West Division although they are not uncommon in deposits of this area particularly in the Cape Leeuwin—Cape Naturaliste region (Merrilees 1968).

The Murray Cave fauna includes the following species (specimens registered as 72.1.1148-72.1.1170):

	Metatheria
Dasyuridae	*Antechinus apicalis* *Antechinus flavipes* *Dasyurus geoffroii* *Sarcophilus harrisii*
Thylacinidae	*Thylacinus cynocephalus*
Peramelidae	*Isoodon* sp.*
Phalangeridae	*Trichosurus vulpecula*
Petauridae	*Pseudocheirus peregrinus*
Macropodidae	*Bettongia lesueur* *B. penicillata* *Macropus irma* *M. eugenii* *Petrogale penicillata* *Setonix brachyurus*
	Eutheria
Vespertilionidae	(indet)*
Megadermatidae	*Macroderma gigas*
Muridae	*Rattus fuscipes* *pseudomyine* (indet)*

* See note at bottom of the "Tunnel Creek Carnivore Lair" list above. In addition there is at least one species of lizard, one species of frog and three species of terrestrial snails.

The bone material from Murray Cave is considered to represent a carnivore's accumulation. As in the "Tunnel Creek Carnivore Lair" deposit reported above, the larger species are mainly represented by specimens of juvenile individuals. It differs from the "Tunnel Creek Carnivore Lair" deposit in that almost every bit of bone is broken into much smaller pieces, including most of the jaws. Bone destruction of this sort is typical of *Sarcophilus harrisii* (Douglas, Kendrick and Merrilees 1966).

One of the individuals of *Thylacinus cynocephalus* from Murray Cave consist of a maxilla and dentary representing a very small pouch-young thylacine (Fig. 2). The roots of the crowns had not yet formed and the teeth are stacked in overlapping positions in the dentary. There is little doubt that this animal was taken into Murray Cave, either by or with its mother, or by a predator.

The Hampton Tableland of the Eucla Division

In 1969 and 1970 Messers B. Muir, K. Akerman, and others accompanied the author to Horseshoe Cave (N59) northeast of Madura on the Hampton Table and where three excavations were dug and a large fauna recovered (to be fully reported elsewhere). This fauna included

Figure 2.—The Murray Cave juvenile thylacine specimen (72.1.1149). The teeth probably would not have pierced the gum at this stage of dental development and the animal would have been totally dependent on its mother.

Thylacinus cynocephalus. Specimens (registered as 72.1.1-72.1.1000 etc.) from the same deposit represent the following species:

	Metatheria
Dasyuridae	*Sminthopsis crassicaudata* *Sminthopsis murina* *Antechinomys spenceri* *Phascogale calura* *Dasycercus cristicauda* *Sarcophilus harrisii* *Dasyurus* cf. *D. geoffroii*
Thylacinidae	*Thylacinus cynocephalus*
Peramelidae	*Perameles* cf. *P. bougainville* *Chaeropus ecaudatus* *Isoodon obesulus* *Macrotis lagotis*
Phalangeridae	*Trichosurus vulpecula*
Burramyidae	*Cercartetus* cf. *C. concinnus*
Vombatidae	*Lasiorhinus latifrons*
Macropodidae	*Caloprymnus campestris* *Bettongia lesueur* *B. penicillata* *Onychogalea lunata* *Lagorchestes* cf. *L. hirsutus* *Lagostrophus fasciatus* *Petrogale* sp. *Megaleia rufa*

	Eutheria
Muridae	*Pseudomys* cf. *P. gouldii* *P. occidentalis* *P. desertor* *P. hermannsburgensis* *Leporillus apicalis* *L. conditor* *Notomys cervinus* (and probably other species of the genus) *Rattus* cf *R. vellosissimus*
Hominidae	*Homo sapiens*
Canidae	*Canis familiaris*
Vespertilionidae	Small bats (indet)*

* See note at the bottom of the "Tunnel Creek Lair" list above.

Sminthopsis murina, *Pseudomys* cf. *P. gouldii*, *P. desertor*, and *Rattus* cf. *R. villosissimus* have not previously been recorded from the Hampton Tableland.

Thylacine remains have been reported from the Hampton Tableland (e.g. Partridge 1967, Lowry and Merrilees 1969). A date of 3 280 ± 80 radiocarbon years reported by Partridge (1967), was based on dried flesh from a thylacine found on the surface of Murra-el-elevyn cave. Dates of 4 650 ± 104, 4 550 ± 112 and 4 650 ± 153 radiocarbon years B.P. are reported by Lowry and

Table 1

Thylacine and dog remains from trench excavations in Horseshoe Cave (N59).

T = thylacine, D = dog. There are also dog remains on the surface of the cave floor. The synopsis column gives a summary of the dog, thylacine and relevant dates from particular trench excavations (no. in parenthesis).

Depth (cm)	Trench 1	Depth (cm)	Trench 2	Depth (cm)	Trench 3	Synopsis
						D on surface
				30–40	D (e.g. 72.1.691)	D 30–40 (3)
		40–50	T (e.g. 72.1.482)			
		50–53	T (e.g. 72.1.512) (date from 50–53 level: 7030 ± 130, GaK-3888, bone)	50–60	3570 ± 100 (GaK-3570, bone) and 4500 ± 330 (GaK-3476, charcoal)	4500 ± 330 (3)
90–100	T (e.g. 72.1.155)					T 90–100 (1)
110–120	5630 ± 120 (GaK-3814, bone)					5630 ± 120 (1)
200–220	T (e.g. 72.1.307)					T 200–220 (1)
250–260	15800 ± 1800 (GaK-3815, bone)					15800 ± 1800 (1)

Merrilees (1969) for a thylacine mummy from the surface of Thylacine Hole cave. Thylacine remains from Horseshoe Cave (N59) are summarized in Table 1 with radiocarbon dates and the stratigraphic levels containing dog remains. The specimen (72.1.512) from the Trench 2 level dated at 7 030 ± 130 radiocarbon years B.P. is the oldest dated thylacine from the Hampton Tableland. The specimen (72.1.307) from the Trench 1 200-220 cm level may represent an even older thylacine.

Discussion

It is now clear that during Quarternary time, thylacines existed throughout the Australian continent, as well as in New Guinea and Tasmania. However, the reasons for the decline of the thylacine are not clear. Fleay (1946) believes that snares and baits laid by European hunters were the cause for the decline of Tasmanian thylacines. Merrilees (1968) and Jones (1968) suggests that Aborigines may have played a major role in the extinction of some of Australia's Quaternary marsupials. Troughton (1967) and Jones (1970) suggest that competition with dogs may have been a major reason for the decline of the thylacine.

Although thylacine remains have occasionally been recovered from excavations that contain Aboriginal remains or artifacts (e.g. Fromm's Landing, MacIntosh and Mahony 1964, Horseshoe Cave reported in this paper) there is no evidence (such as burned thylacine bones in midden deposits) to suggest Aborigines actively hunted thylacines. Aboriginal man might have been responsible for destroying such vital aspect of the thylacine's habitat such as the vegetation or food supply. But the fact that thylacines and Aborigines persisted together into historic times in Tasmania suggests co-existance could have also taken place on the mainland. Wright (1971) presented evidence for Aboriginal activity in Koonalda Cave on the Hampton Tableland of the Nullarbor. He states (p. 28) that "... traces of human activity are present from roughly 22 000-15 000 years ago". Considering the date of 3 280 ± 80 radiocarbon years B.P. recorded by Partridge (1967) for thylacine remains in Murra-el-elevyn Cave on the Hampton Tableland, thylacines and Aborigines probably co-existed on the Hampton Tableland for at least 18 000 radiocarbon years. Therefore Aborigines were probably not responsible for the decline of the thylacine on the Australian mainland or Tasmania.

Dogs and thylacines

Tindale (1959) suggests that dogs were originally brought into Australia by Aborigines The oldest known dog remains in Australia are from a cave at Mt. Burr in South Australia, and are dated at between 7 450 ± 270 and 8 600 ± 300 radiocarbon years B.P. (Mulvaney 1969). Dogs occur in New Guinea (Troughton 1971), formerly occurred in New Zealand (Allo 1971) but are not known to have occurred in Tasmania prior to the arrival of Europeans around 1798 (Jones 1970). Jones (1968) suggests that Tasmania has been separated from the Australian mainland for about 12 000 years and that therefore (p. 258) it "... seems highly likely that the dingo first appeared in Australia after about 12 000 years ago, and in view of the Mt. Burr evidence some time before 7 000 years ago". Merrilees (1968) has suggested that a dog tooth in the Western Australian Museum collections from the Mammoth Cave deposit probably did not come from the Pleistocene deposit in that cave (which is dated at greater than 31 000 and 37 000 radiocarbon years B.P.) and Jones (1970) states (p. 258) that "Claims for dog teeth in Pleistocene (Australian) deposits have not been confirmed".

Thylacine remains are known from Australian, Tasmanian and New Guinean late Quaternary deposits (Merrilees 1968, Van Deusen 1963, Gill 1963, Gill and Banks 1956) and may have been sympatric with dogs that occurred in New Guinea and Australia. Actual instances of the sympatric occurrence of the two species interpretable from fossil deposits in Australia have not been clearly demonstrated. At present the only instance known to me is that recorded by Wakefield (1967). He reports dog and thylacine remains from the same "Recent" layer in the McEachern's Cave in southwest Victoria. This layer is 14 inches thick. Wakefield (1967) also reports dog and thylacine remains from a "mixed" sand at depth of 14 to 30 inches. It is possible that this report indicates the two species were sympatric.

On the other hand there are several deposits in which large excavations have revealed superposition of dog remains over those of thylacines (e.g. Wakefield in Mulvaney, Lawton and Twidale 1964). In Horseshoe Cave (reported in this paper and by Archer 1972) on the Hampton Tableland dog remains occur in two of the three excavated trenches but only at levels above levels containing thylacine remains (see above). Lowry and Merrilees (1969) report a radiocarbon date of 220 ± 96 years B.P. for a desiccated carcase of a dog from another cave on the Hampton Tableland. This date is younger than any that applies to thylacine remains in Australia. In fact I am unaware of any radiocarbon dated sequences in Australia which demonstrate an example of superpositional relationship of thylacine over dog remains. It is possible that the thylacine remains reported in this paper from the "Tunnel Creek Carnivore Lair" Kimberley deposit are contemporaneous with the fauna which has been radiocarbon dated at 0 ± 80 years B.P. (see above). If this is the case it is most likely that dogs and thylacines have been sympatric in northern Australia for some unknown time. But considering that the thylacine remains in this Kimberley deposit are (as noted above) somewhat differently preserved from the other bones in the deposit, it cannot be argued on the evidence of this deposit alone that thylacines were sympatric with dogs in northern Australia.

What little is known of New Guinean thylacine and dog history suggests a similar situation. White (1971) suggests (p. 190) that dog remains are found in New Guinea shelter sites "... only in very recent times ...". On the other hand thylacine remains have been recorded by Van Deusen (1963) from the Kiowa Rock Shelter in New Guinea above a level dated at $9\,920 \pm 200$ years B.P. (Bulmer 1964 and Van Deusen pers. com.).

Tasmanian thylacines are reputed (e.g. Troughton 1967) to have eaten wallabies, smaller marsupials, rats, birds, probably echidnas and possibly lizards as natural foods. Rolls (1969) records (p. 361) that following an active and successful campaign to reduce the numbers of wild dogs (dingo) in southeast Australia in 1863 "... there began a startling build-up of wildlife. Kangaroos, wallabies, pademelons, rat-kangaroos, bilbies, and bandicoots which had all been present in insignificant numbers sprang up like grass". Although it is possible that factors other than the reduction of dog numbers might have contributed to this resurgence of wildlife, it would seem probable that dogs could usurp the thylacine's natural foods in areas where the two carnivores were sympatric. Calaby (1971) says (p. 90) of the introduced dog that it "... is an opportunist predator with a catholic diet including virtually anything it can catch, vertebrate or invertebrate, together with carrion and even some vegetable material". I have recently examined stomach contents of dogs trapped in northwestern Western Australia (by courtesy of Mr. Simon Whitehouse) and identified specimens of feral cats (*Felis domesticus*) in two stomachs. It is therefore not unlikely that dogs might even have preyed directly on thylacines if given the opportunity. The dog and thylacine are of comparable size and partitioning of the habitat without a long historical basis, probably would not have occurred.

Further evidence for competition between dogs and thylacines comes from a consideration of the Tasmanian situation. Dogs are not known to have been present in Tasmania prior to historic times (Jones 1968). Thylacines on the other hand persisted in Tasmania despite the presence of Aborigines (see above). It could be argued that the introduction of dogs into Tasmania in historic times was a significant reason for the eventual decline of the thylacine in Tasmania. Guiler (1961) examined records of thylacine kills by European hunters in Tasmania. He noted that the number of thylacines killed remained relatively constant in two areas where killing for bounties had begun in 1888, until the sudden general decline throughout Tasmania around 1909, rather than gradually declining in those areas. He concluded that for this reason hunting by Europeans was not the sole cause of the thylacine's decline. He suggested disease might have been a factor in causing the decline. The same argument could be used to suggest that no single gradual pressure, including pressures caused by the introduced dog, brought about the Tasmanian thylacine's decline. Guiler (1961) did not however consider that predation by Europeans (and or competition with the dog during historic times) may have been responsible for lowering the thylacine populations in Tasmania to a critical level at which disease or some other factor could have dealt a crushing blow. It would seem too much of a coincidence that the Tasmanian thylacine population declined so drastically for unknown reasons during the only 11 year period of Quaternary time when it was also actively and methodically predated upon by human hunters. Whatever the cause for Tasmanian thylacine decline, the fact that thylacines existed in Tasmania into historic times and evidentely did not on the Australian mainland, suggests that dogs may have been the significant factor which brought about the decline of the thylacine on the Australian mainland.

There would appear to be no comparable situation within recent time involving introduced dogs and indigenous dog-sized, non-canid carnivores on any other continent. Dog-sized canids are indigenous to Africa, e.g. jackals, *Canis adustus*, bush dogs, *Lycyon pictus*), South America (bush dogs, *Speleothos* spp., maned wolves, *Chrysocyon* sp. etc.), and North America, Europe and Asia (grey wolves, *Canis lupus*). On the other hand a similar situation occurred in South America during late Pliocene (Montehermosan) time. In South America the only large carnivores were the marsupial borhyaenids which included thylacine-like and thylacine-sized animals. When faunal interchange became possible across Panama, canids, procyonids, ursids, mustelids and felids entered South America and successfully colonized the continent, whereas the borhyaenids became extinct (Patterson and Pascual 1968). It is probably not possible to know what particular role the canids had in displacing the borhyaenids.

Colbert (1955) suggests that marsupials are "second-class mammals" as compared with eutherians. This impression arises as a result of the apparent competitive inferiority exhibited by many marsupial groups. Storr (1958) has argued that this is because most marsupials evolved in isolation on southern continents. They were not subjected to the constant testing that Holarctic eutherians underwent. Thylacines were in this sense at a disavantage in a confrontation with the dog. The modern dog is a representative of a stock of eutherians that had already successfully confronted the South American marsupial borhyaenids. The Australian thylacine probably had even less of a chance for survival against such a seasoned competitor than the South American Borhyaenids.

Acknowledgements.—Collections upon which this paper was based were made while the author was carrying out research under a Fulbright Scholarship from the Australian American Educational Foundation, a grant in aid from the American Explorers Club, and as a research assistant to Dr. W. D. L. Ride who was in receipt of a Research Grant from the Australian Research Grants Committee. Dr. Ride is the Director of the Western Australian Museum. Dr. R. E. Lemley of Rapid City, South Dakota, provided the finances to support Mr. A. M. Douglas, the author and himself on an expedition to northern Australia. Sir Thomas Wardle helped finance certain aspects of the work on the Hampton Tableland in 1970. Mr. I. Murray was instrumental in discovering and with Miss E. A. Jefferys and the author in helping to recover the fauna from Murray Cave. Messrs. B. Muir, K. Akerman, D. Brindle, J. Leahey, and C. Chubbs helped make collections from Horseshoe Cave and other caves on the Hampton Tableland. Many other people and in particular Master M. Hearne and Miss E. A. Jefferys (now Mrs. M. Archer) provided invaluable assistance in sorting the material obtained from Horseshoe Cave. Drs. D Merrilees, D. Kitchener and Mr. G. W. Kendrick of the Western Australian Museum kindly read and criticised the manuscript. I am grateful to Dr. D. Merrilees for providing many of the macropodid identifications, to Messrs. J. Mahoney and A. Baynes for providing the murid identifications, and to Mr. G. W. Kendrick for providing comments about the invertebrate remains. Dr. Hobart Van Deusen provided comments and information about the age of the Kiowa New Guinea thylacine specimen.

References

Allo, J. (1971).—The dentition of the Maori Dog of New Zealand. *Records of the Auckland Institute and Museum* 8: 29-45.

Archer, M. (1971).—A re-evaluation of the Fromm's Landing thylacine tooth. *Proceedings of the Royal Society of Victoria* 84: 229-234.

Archer, M. (1972).—Nullarbor 1969. *Western Caver* 12: 17-24.

Brain, C. K. (1967).—Bone weathering and the problem of bone pseudo-tools. *South African Journal of Science* 63: 97-99.

Brandl, E. J. (1972).—Thylacine designs in Arnhem Land rock paintings. *Archaeology and Physical Anthropology in Oceania* 7: 24-30.

Bulmer, S. (1964).—Radiocarbon dates from New Guinea. *Journal of the Polynesian Society* 73: 327-328.

Calaby, J. H. (1971).—Man, fauna and climate in Aboriginal Australia, pp. 80-93 in *"Aboriginal man and environment in Australia"*, (D. J. Mulvaney and J. Golson, ed.) 1-389. Australian National University Press, Canberra.

Colbert, E. H. (1955).—*"Evolution of the vertebrates"*, 1-479. John Wiley and Sons Inc, New York.

De Vis, C. W. (1894).—A thylacine of the earlier nototherian period of Queensland. *Proceedings of the Linnean Society of New South Wales* 8: 443-447.

Douglas, A. M., Kendrick, G. W. and Merrilees, D. (1966).—A fossil bone deposit near Perth, Western Australia, interpreted as a carnivore's den after feeding tests on living *Sarcophilus* (Marsupialia, Dasyuridae). *Journal of the Royal Society of Western Australia* 49: 88-90.

Estes, R. D. (1967).—Predators and scavengers. Part II. *Natural History* 76: 38-47.

Fleay, D. (1946).—On the trail of the marsupial wolf (in three parts). *Victorian Naturalist* 63: 129-135, 154-159, 174-177.

Gill, E. D. (1953).—Distribution of the Tasmanian Devil, the Tasmanian Wolf, and the Dingo in S.E. Australia in Quaternary time. *Victorian Naturalist* 70: 86-90.

Guiler, E. R. (1961).—The former distribution and decline of the thylacine. *The Australian Journal of Science* 23: 207-210.

Jones, R. (1968).—The geographical background to the arrival of man in Australia and Tasmania. Archaeology and Physical Anthropology in Oceania 3: 186-215.

Jones, R. (1970).—Tasmanian Aborigines and dogs. *Mankind* 7: 256-271.

Macintosh, N. W. G., and Mahoney, J. A. (1964).—A 4 000 years old thylacine tooth (Dasyuridae) from shelter 2, pp. 507-516. Appendix in "Archaeological excavation of Rock Shelter no. 6, Fromm's Landing, South Australia" by Mulvaney, D. J., Lawton, G. H., and Twidale, C. R., *Proceedings of the Royal Society of Victoria* 77: 479-516.

Marlow, B. (1968).—*"Marsupials of Australia"*, 141 pp. Jacaranda Press Pty. Ltd., Brisbane.

Merrilees, D. (1968).—Man the destroyer: late Quaternary changes in the Australian marsupial fauna. *Journal of the Royal Society of Western Australia* 51: 1-24.

Mulvaney, D. J. (1969).—*"The prehistory of Australia"*, 276 pp. Thames and Hudson, London.

Partridge, J. (1967).—A 3 300 year old Thylacine (Marsupialia, Thylacinidae) from the Nullarbor Plain, Western Australia. *Journal of the Royal Society of Western Australia* 50: 57-59.

Patterson, B. and Pascual, R. (1968).—Evolution of Mammals on southern continents. The fossil mammal fauna of South America. *The Quarterly Review of Biology* 43: 409-451.

Polach, H. A. and Golson, J. (1966).—Collection of specimens for radiocarbon dating and interpretation of results. *Australian Institute of Aboriginal Studies, Manual No.* 2: 1-41.

Ride, W. D. L. (1970).—*"A guide to the native mammals of Australia"*, 249 pp. Oxford University Press, Melbourne.

Rolls, E. C. (1969).—*"They all ran wild"*, 444 pp. Angus and Robertson, Sydney.

Smith, E. M. (ed.) (1963).—"Lexigue Stratigraphique International, Vol. 6—Oceanie, Fasc. 5—Australia 5f—Western Australia." (Centre national de la Recherche Scientific, Paris).

Storr, G. M. (1958).—Are marsupials "second-class" mammals? *The Western Australian Naturalist* 6: 179-183.

Tindale, N. B. (1959).—Ecology of primitive Aboriginal man in Australia. pp. 36-51 in *"Biogeography and ecology in Australia"* (Keast, A., Crocker, R. L. and Christian, C. S., ed.) 640 pp. The Hague.

Troughton, E. (1967).—*"Furred animals of Australia"*, 384 pp. Angus and Robertson, Sydney.

Troughton, E. (1971).—The early history and relationships of the New Guinea highland dog (*Canis hallstromi*). *Proceedings of the Linnean Society of New South Wales* 96: 93-98.

Van Deusen, H. M. (1963).—First New Guinea record of *Thylacinus*. *Journal of Mammalogy* 44: 279-280.

Wakefield, N. A. (1964).—Mammal remains, pp. 494-498. Appendix in "Archaeological excavation of rock shelter no. 6, Fromm's Landing, South Australia" by Mulvaney, D. J., Lawton, G. H., and Twidale, C. R., *Proceedings of the Royal Society of Victoria* 77: 479-516.

Wakefield, N. A. (1967).—Preliminary report on McEachern's Cave S.W. Victoria. *The Victorian Naturalist* 84: 363-383.

White, J. P. (1971).—New Guinea and Australian prehistory: the "Neolithic problems". pp. 182-195 in *"Aboriginal Man and Environment in Australia"*, (Mulvaney, D. J. and Golson, J. ed.), 389 pp. Australian National University Press, Canberra.

Wright, B. J. (1968).—Rock art of the Pilbara Region, north-west Australia. *Australian Institute of Aboriginal Studies Occasional Papers in Anthropological Studies* **11**: 1-78.

8.—Petrology of chert artifacts from Devils Lair, Western Australia

by J. E. Glover[1]

Manuscript received 17 July 1973; accepted 21 August 1973

Abstract

Fossiliferous chert artifacts from Devils Lair, a small cave in the Cape Leeuwin-Cape Naturaliste region, Western Australia, consist of silicified limestone (biomicrite) containing a little glauconite. Specimens examined in thin section came from deposits ranging in age from *ca* 12 000 years B.P. to more than 17 000 years B.P. They resemble fossiliferous Eocene chert from surface and near-surface sites in the Perth Basin, and are probably derived from the same formation.

Introduction

Flakes of chert and quartzite worked by aborigines have been found at many sites in and just outside the region of the Perth Basin, and form abundant components of surface or near-surface accumulations. Other utilized rock and mineral flakes, including dolerite, granite, silcrete, quartz, schist and K-feldspar are commonly present as minor constituents. Chopping and grinding tools, generally of dolerite or quartzite, are found in a few places. Some of the chert is unfossiliferous and of probable Precambrian age, but most of it is bryozoan chert of Eocene age (Glover & Cockbain 1971).

This paper describes the petrology of some chert flakes excavated from the Devils Lair cave outside the Perth Basin, and compares it with the petrology of flakes from surface scatters within the region of the basin.

Location and age of the artifacts

Devils Lair is a small cave in Quaternary limestone (the "Coastal Limestone") on the Precambrian Leeuwin Block (Fig. 1) and it contains a deep deposit with abundant bone fragments and some stone artifacts (Dortch & Merrilees 1971, 1973). The artifact material includes chert (five individual specimens of which are described herein), quartz (*e.g.* B1558), calcrete

[1] Geology Department, University of Western Australia, Nedlands, Western Australia 6009.

Figure 1.—Locality map of southwestern Western Australia. Precambrian indicated by crosses. Eocene units as follows: P = Plantagenet Group, E = Eundynie Group, T = Toolinna Limestone. All artifacts mentioned in the text, except those from Devils Lair and the Pinnacles area, come from in or near the Perth metropolitan area.